Thermal Transport Through Thin Films:
Mirage Technique Measurements on Aluminum/Titanium Multilayers

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Thin films of polymers, metals, and ceramics are playing an ever increasing role in the development of integrated circuits and optoelectronic devices. To enhance performance, technology demands a reduction in both the thickness of deposited films and the width of metallization lines. At the same time, devices are composed of increasingly complex multilayered structures. For modeling and lifetime predictions of these structures, it is necessary to know material properties of films with great certainty. Unfortunately, both the thermal diffusivity of a thin film and the relative significance of interface thermal resistance are functions of the film thickness. In addition, the geometry of stacked thin films can produce non-isotropic material response. We have, therefore, investigated the thermal transport properties of multilayer thin films both normal and parallel to the layers using the mirage method. Three µm thick Al/Ti multilayer films on Si substrates, with individual layers systematically varied from 2.5 nm to 40 nm, were studied. The thermal diffusivity both in the plane and normal to the plane of the films was found to decrease significantly with decreasing bilayer thickness. The interface thermal resistance was calculated from the dependence of the thermal diffusivity on bilayer thickness. The properties of homogeneous Ti and Al 3 µm thick films, as well as Cu films ranging from 0.1 to 5 µm thick, were also investigated.